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THE FRENCH ATLANTIC LITTORAL
AND THE MASSIF ARMORICAIN

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15. Abstract This report concerns the geological study of the Massif Armoricaïn, made on the basis of landsat 2 images. The survey was realized as a part of the "French Atlantic littoral and the Massif Armoricaïn" investigation proposed to NASA, the Professor VERGER being principal investigator. The significant results are both scientific and methodologic and concern: the preparation of an original map of lineaments, the verification of validity and nature of spatial information, the confirmation of the accessibility of Landsat data to deep geological phenomena. The interest of linear crossings and circular structures in the search for mineral occurrences. The ability of the QTM 720 image analyser for analysis of the linear pattern. The feasibility of the Vizir image processor to generate good quality improved images from the digital tapes.			

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1 - INTRODUCTION

This report concerns geological results obtained during the investigation conducted by professor VERGER, principal investigator, along the French Atlantic littoral and in the Massif Armoricaïn.

Interpretation and mapping of Landsat 2 data has been initiated singly or in connection with Landsat 1 data, with emphasis on distribution of known ore occurrences along lineamenty and search for geophysical and geological correlations.

2 - TECHNIQUES

2.1 - Imagery products

The study was made on the basis of photographs to the scale of 1/1,000,000 obtained by enlarging negatives which NASA supplied to the "principal investigator", Professor VERGER.

We have experimented with a process for improving the image by means of digital tape purchased from Eros Data Centre for the border zone of the Massif Central (Limoges-Ruffec region) which we had already studied as principal researcher of the ERTS. I project, "structural geology investigation in the Massif Central, France". This experimentation was carried out in collaboration with the Institut français du pétrole. This type of improvement is obtained through a non-linear transformation of the image histogram so as to achieve better contrast for what is most represented on the image. Processing is carried out on a CDC 7600 computer with replay on a VIZIR numerical image restitutor owned by the IFP. The films are 40 x 40 cm allowing a complete Landsat image to be represented at the scale of 1/500,000.

Study of the images was considerable facilitated by this kind of improvement especially when work is performed on enlargements. Contrasts are excellent (in comparison with the same image purchased from NASA and photographically enlarged) ; and interpretation of the lineaments is much more reliable since the interpreter has more confidence in the material being interpreted. The results are much better at the level of lithological detail and additional observations are possible (for example in the Uzerche syncline near Tulle).

We have realized a composite colour on this image on the basis of NASA films utilizing the Cromalin process adapted by the graphic arts department of B.R.G.M.. The advantage of the B.R.G.M. process over the first process is that the half-tone film is used directly without recourse to "screening" as was previously the case. At the level of interpretation, the composite images are an improvement in the sense that they supply additional elements and ease, as has been stressed by many interpreters.

LOCATION MAP

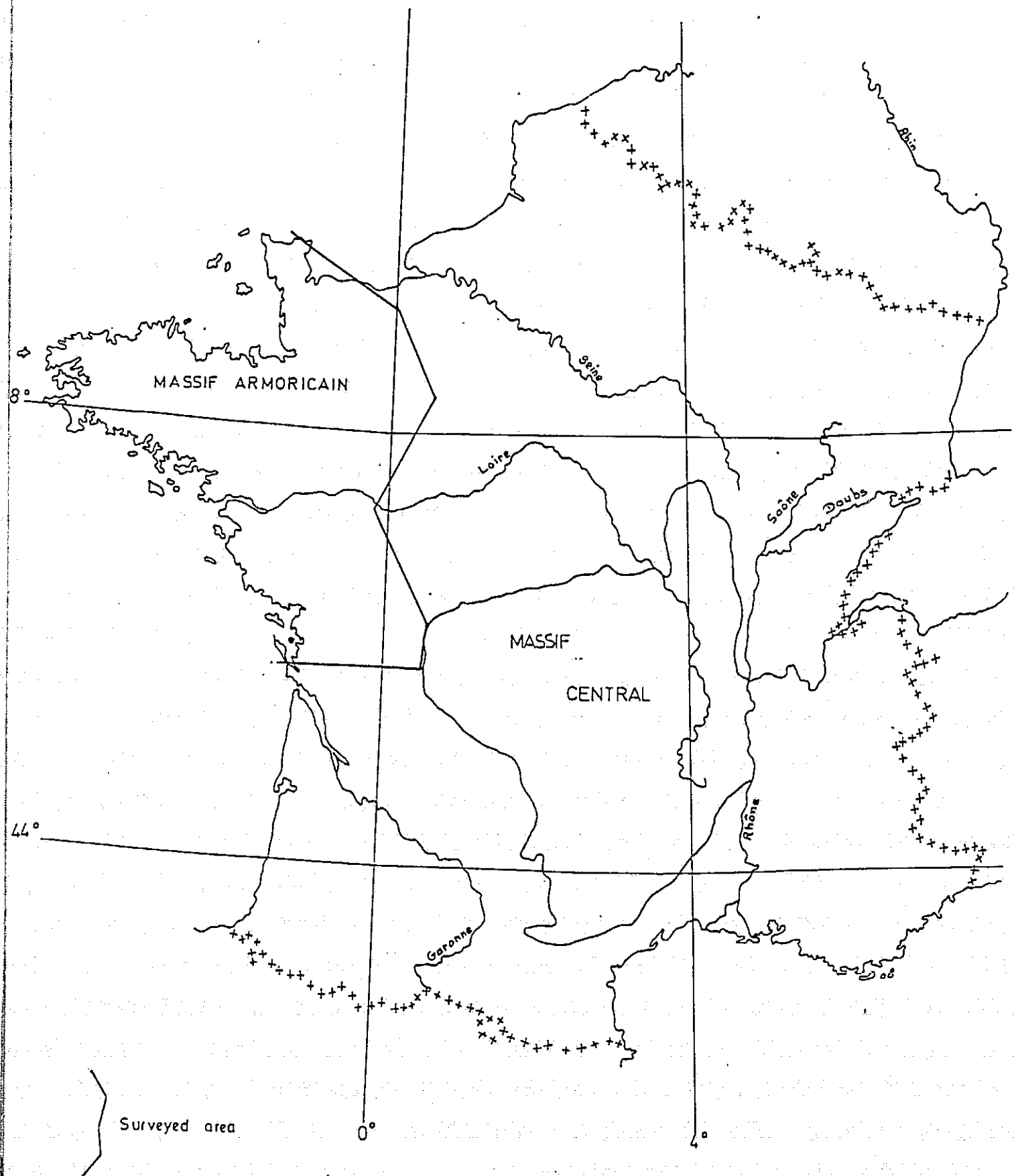


Fig. 1

2.2 - Work procedure

The interpretation of the various spectral bands is carried out on a transparent paper superimposed on the Landsat image and under a stereoscope which, in spite of a part that there is no stereoscopic effect, makes it possible to compare immediately the data resulting from the various bands.

This interpretation is then, under the same conditions, composed with images which are of the same zone but for another period, or made by another satellite (Landsat I), or from another orbit, sometimes making it possible to produce the (always desired) stereoscopic effect for a limited part of the image.

All interpretations are then platted on a topographical background of the same scale, it being understood that sufficient planimetric details (rivers, lakes, cities) are indicated on the tracings so as to supply fixed points and compensate the slight differences which might occur in the course of the progressive adjustments.

Comparisons with the geological, geophysical etc. maps were made by superimposing the prepared document on a transparent medium.

The analysis of lineaments was carried out by the "quantitative television microscopy 720" image analyser. The principle is as follows:

From a film of the tracing of the interpretation of the satellite lineaments, an optical image is obtained by reflection which is caught by a television camera and displayed on monitoring screen. At each point of this image an analysis spot delivers an electrical signal proportional to the perceived luminous flux. The televised image of the sought-for effect is then photographed. By means of the Q.T.M. it is possible to determine the average trends of families and faults, sort out fractures in terms of their size, etc.. For the Armorican Massif we have prepared maps of density and filtration strikes and maps of the intensity of lineament intersection while other research is being carried out (see figure).

2.3 - Ground truth

During this study there were no field verifications properly speaking since it did not seem possible to check all the information supplied by the Landsat images. The Landsat 1 experiment which we carried out from 1972 to 1974 led the field geologists responsible for plotting the 1/50,000 maps to reflect on the abundant new data supplied by the spatial images and the first results only began to be known in 1976. For example, DEBRAND-PASSARD after the systematic work of plotting the sedimentary zones of the Vierzon-Chateauroux region at 1/50,000 was able to correlate the 30° N satellite lineaments (see NASA report, ERTS 1 SR 003-1 "Structural investigation in the Massif Central, France, January 1974") with a group of tectonic anomalies which emphasize this trend and its importance [oral communication].

For the translation of most of the observations made by the ERTS into terms accessible to the geologist, long and detailed field studies and complex studies utilizing geophysical techniques are necessary.

There is therefore a favorable opportunity for obtaining results since remote sensing has furnished considerable data in a short time. The verifications which we have made, and they are quite numerous, consist in a comparison of the map of satellite lineaments with all existing maps related to the research. There are many maps of this kind for Brittany and this has made possible an interesting comparison.

In addition, for several localized zones we have prepared classical photogeological minutes on the basis of panchromatic photographs which exist for all of France on the scale of 1/25,000. These studies which are centred on fractures, have made it possible to formulate some conclusions on the comparative utility of the two techniques while indicating once more their "complementary character". The distance from which the satellite images are made often reveals the importance of a fault strike which was underestimated by the interpretation of aerial photographs alone. We have confirmed this for the Quintin and Huelgoat granites.

3 - ACCOMPLISHMENTS

3.1 - Specific data

3.1.1 - Comparison of the lineaments map with other maps

a - Gravimetric map of the Armorican Massif (1966)

The comparison has been made with interpretations at the structural level by J. COGNE and concerning the major displacements by M.J. GRAINDOR. The lineaments observed on the "satellite" images confirm the existence of most of the gravimetric discontinuities hardening the principal structures of the Massif (fig. 3).

- Vendéo-Cornouaille basement
- Ligerien basement and Ligerien cordillera
- Domnoean basement (Léon, Trégor, envelopes of the bay of St-Brieuc)
- Mancellia (not well outlined South of the central trough).

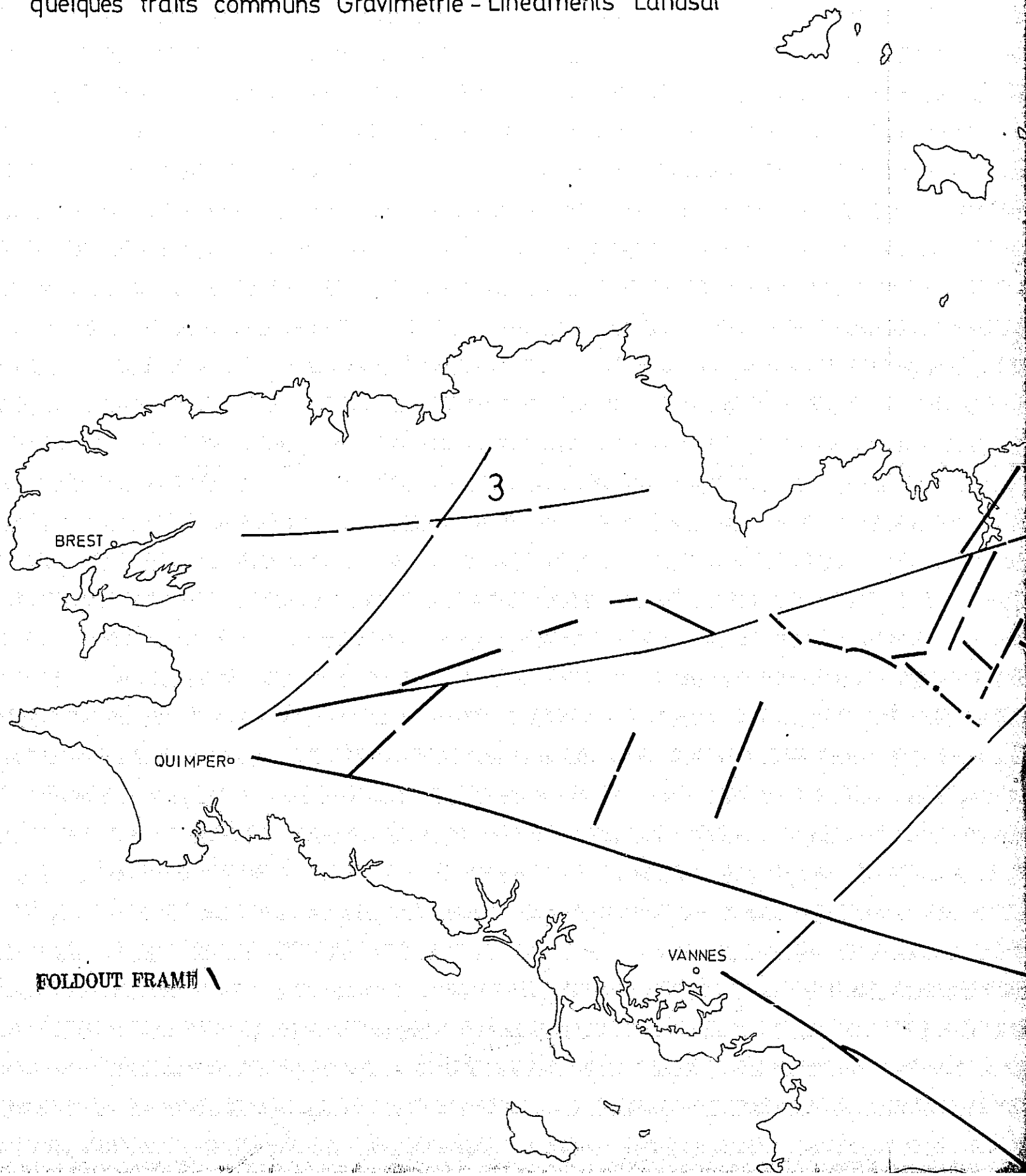
Thus only the northern border of the central trough does not appear very clearly on the Landsat images. It does not correspond to a major line of the spatial interpretation and many less important accidents are scattered over it. There three reasons for this :

1 - It is possible that the very mediocre image quality has interfered with the interpretation.

2 - This major accident and above all its eastern part is located at the border of the two images which introduces another element of the interference.

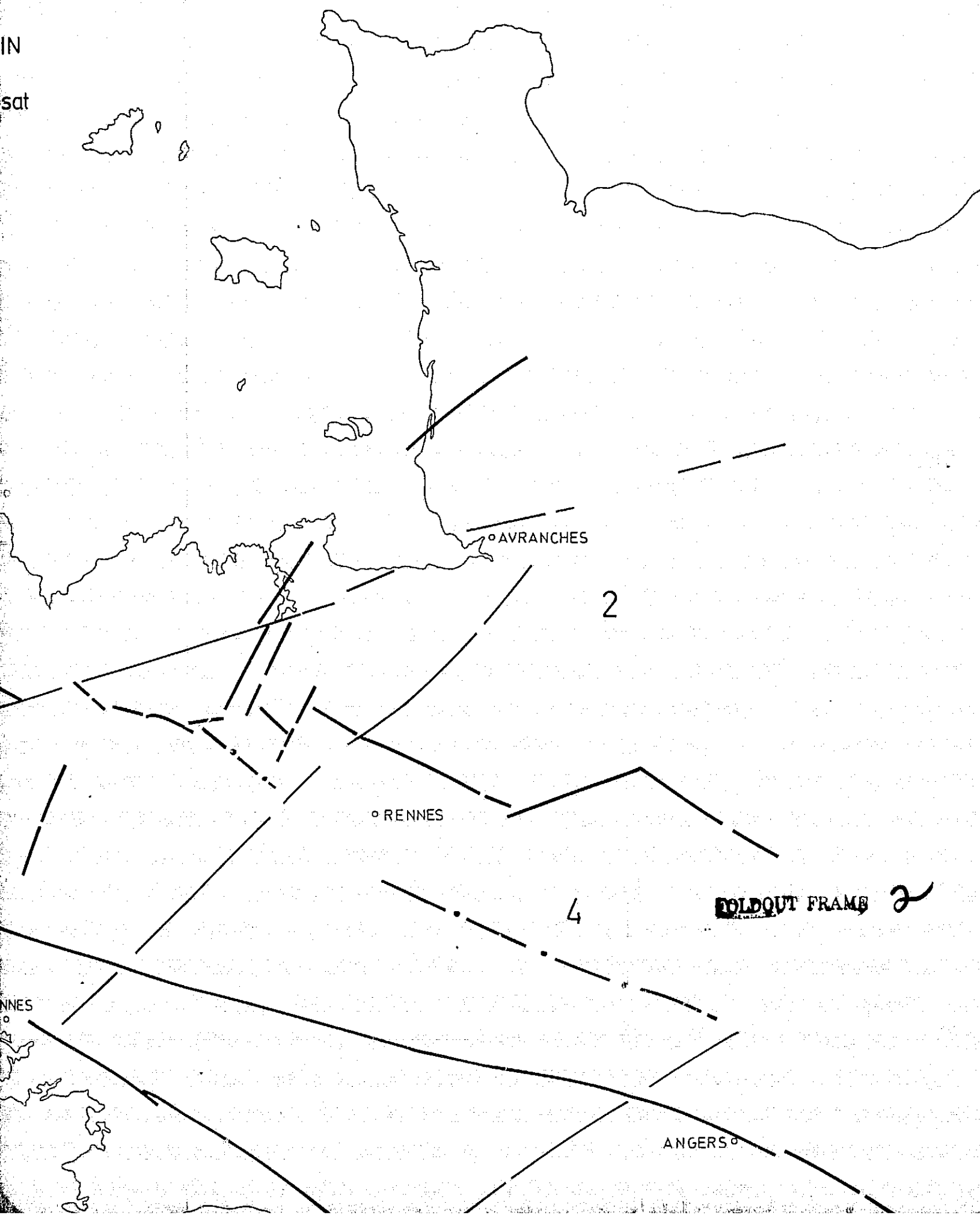
3 - The lineaments map gives importance to the 70°-80° N trend which integrates known elements of the surface geology (Brioverian-Paleozoic boundary, axis of extension of Saint-Malo granite and Granville fault). This accident, and its replica to the North, gives Brittany as seen by satellite a part of its tectonic originality but obliterates the dislocations indicated by gravimetry.

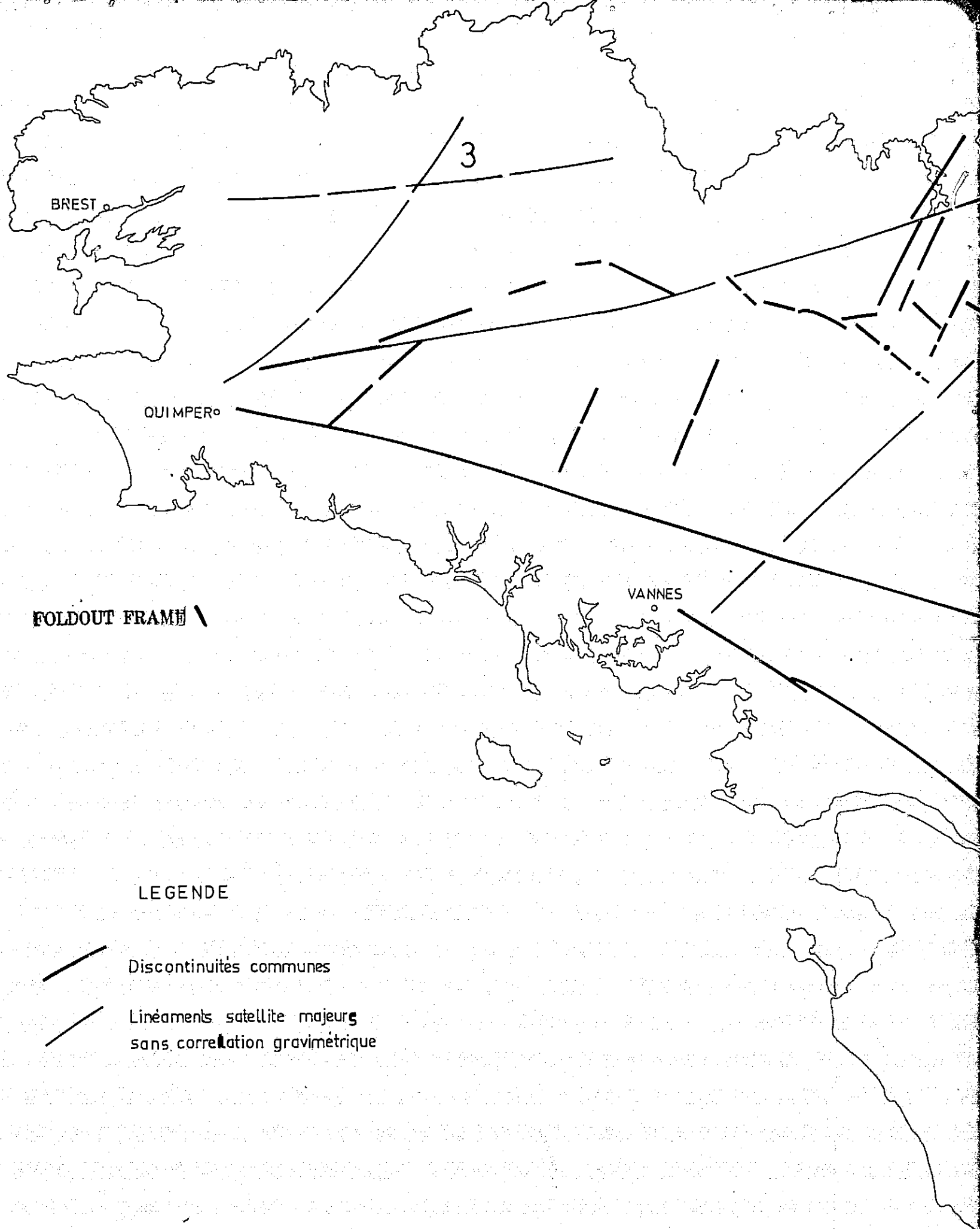
quelques traits communs Gravimétrie - Linéaments Landsat



IN

sat





BREST

QUIMPER

VANNES

FOLDOUT FRAME 3

LEGENDE

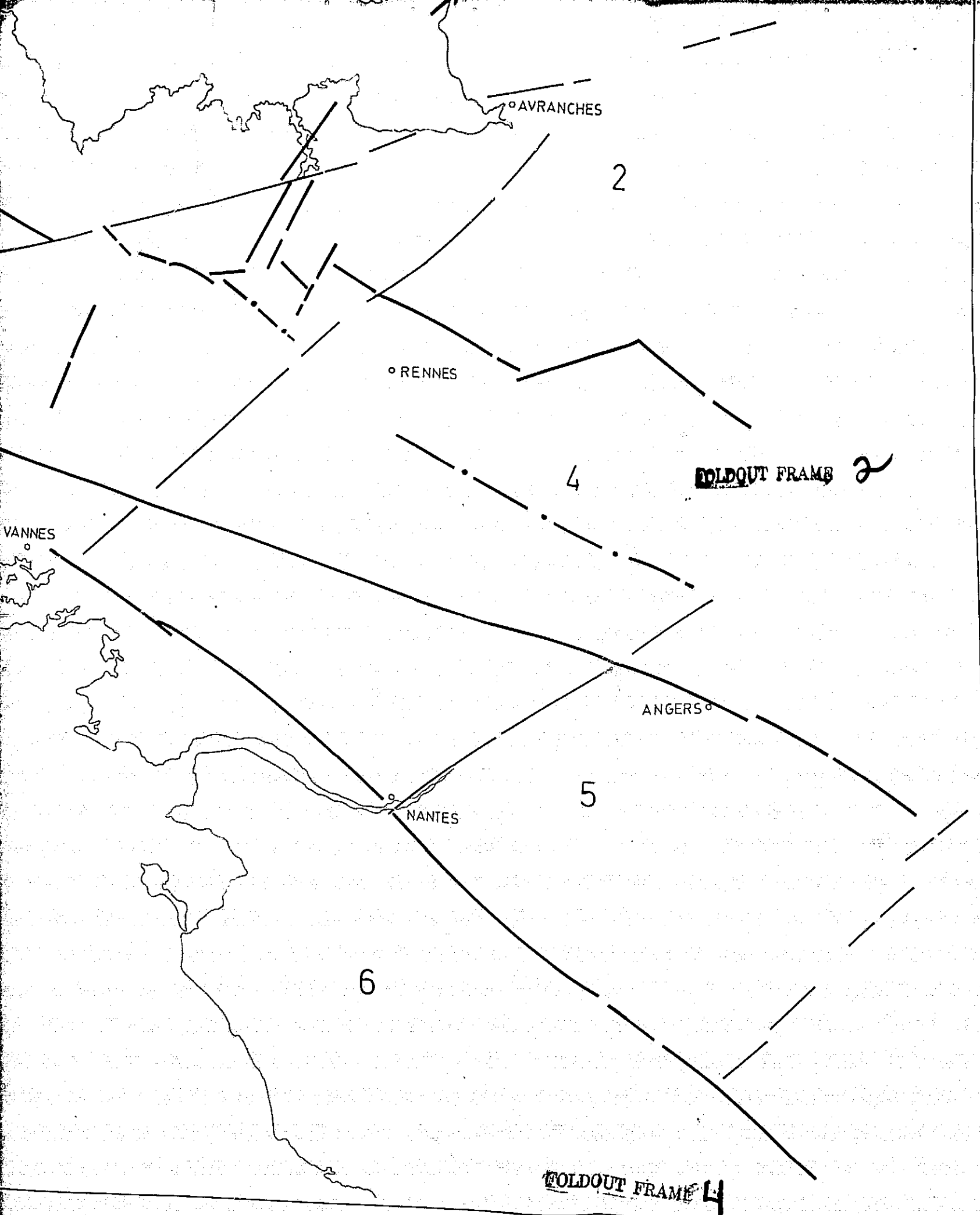


Discontinuités communes



Lineaments satellite majeurs
sans corrélation gravimétrique

FOLDOUT FRAME 3



° AVRANCHES

2

° RENNES

4

FOLDOUT FRAME

2

VANNES

ANGERS °

5

NANTES

6

FOLDOUT FRAME

4

Finally, comparison of the interpretation of gravimetric and spatial data reveals the existence of another 50° North trend which appears with some regularity in the satellite images.

b - Geological map of France

Comparison has been made with the latest edition of the geological map of France, scale 1/1,000,000 (1967). This comparison leads to the following remarks:

1 - Cadomian granites are generally visible in the images. Two remarks can be made on this point:

- The principal massifs, Dol, Dinan Est and Avranches, are not generally indicated by contrasts in tone, which depend upon the formation with which they are in contact, but by the fracturing which brings out the boundaries.

- The Cambourg granite located in Brioverian formations appears in the images through a change in tone, an elliptical form and the fact that this first envelope which corresponds well to the field reality is emphasized by an external belt which then affects the Brioverian. This detail can be considered the expression of the granite in depth or a metamorphic halo.

2 - Hercynian granites:

These granites are not systematically seen on the Landsat images. The case of the Quintin granite is interesting. This massif which is supposed (in the present state of knowledge) to be homogeneous from east to west shows very well in its western part but not in its eastern part. Its appearance as seen from space confirms its shape to the west and emphasizes the possible existence of a closure towards the east. This new image of the massif is a circular one and is not in accordance with field data. Field work is now under way which no doubt will produce an explanation of this original observation i.e. different fracturing, petrographic differentiation or only link to lithological changes in the country rock.

3 - Sedimentary formations:

On high-quality images (Poitou-Charentes), it is possible to differentiate to a high degree the well stratified Jurassic and Cretaceous deposits. The various marshes (Rochefortais, Poitevin) are clearly outlined. The North-West boundary of the Silurian basin of Angers-Redon appears clearly on an image of lesser quality.

The unconformity between the Massif Central basement and the Poitou-Vendée sedimentary formations is clearly seen and this is also true for the Armorican Massif to the North.

c - Metallogenic map of the Armorican Massif

This map which was published in 1969 by Louis CHAURIS and Jean GUIGUES is still up-to-date. The comparison led to the following remarks:

- there is no systematic correspondance between the non-stratiform deposits and the lineaments trends but the percentage of correlation is quite high.

- for certain mineralizations, Pb, Zn deposits of the Poitou shelf, Uranium deposits of Mortagne granite, the relation between the position of the deposits and the principal lineaments trends is confirmed. As concerns

certain deposits, the interpretation of the Landsat images also emphasizes the existence of a second fracture strike at the level of the deposit although for the moment, this does not seem to be systematic.

- Important coincidences have been noted amongst the circular structures interpreted:

At Montbelleux, the structure coincides with a gravimetric anomaly and the presence of a tin mineralization. This structure which is linked to the out-cropping and underlying granite in the Brioverian is located at the intersection of two lineaments.

Near Gourin, 35 km NE of Quimper, the circular structure detected is centred on a small outcrop of granite (diameter 1 km) which intrudes in the Brioverian. The external halo affects the Brioverian formations and the Pliocene covering. Up to the present, no mineralizations are known nor are there alluvial indices. At St-Renan, in the granite of the same name, the circular structure indicated is located in a zone where alluvial prospecting stresses the existence of many indices of tin.

Some of the lineaments discovered on the Landsat images now make it possible to improve understanding of the known deposits:

- the most important French tin-bearing district is located near Nozay in relation with a "belt" of granite which marks the Armorican groove. The fact that it disappears to the east while the geological context is the same could be explained by the existence of an important accident detected in the Landsat images with a 140° N trend which is locally confirmed by gravimetric interpretations.

- a number of the Pb deposits and indices to the north of the Armorican Massif are located within a band which, unfortunately, is quite broad and is bounded to the north and south by two 80° N accidents whose importance we have already emphasized. Should this be considered an extension of the metallogenic Ardenno-Hercynian belt described by P. ROUTHIER ? This link is clear principally to the west of a line Rennes-St-Brieuc but the schema is which then complicated by oblique tectonism of the Armorican type also appears to the east (but it is there shifted towards the SE).

These remarks indicate that at the strategic level the satellite data offers material for reflection which is even more constructive when combined with other types of data and observations.

d - Map of thermal and mineral springs of France

This is a map to the scale of 1/1,000,000 prepared by J. RIESLER (1973). Only two sites in Brittany are given: Bagnoles-de-l'Orne and Plancoët. This is too few to allow conclusions to be drawn.

e - Map of lineaments of France

This is a morphological map prepared by L. DUPLAN in 1973. Comparison stresses that the north-south (slightly north-west) alignments of the Lorient-Plestin-les-Grèves, Concarneau, St Pol-de-Léon type which were detected on the Landsat images and were unknown up to the present time, mark some topographical accidents.

Some other new trends (Angers N° 30) do not mark morphological details.

The co-ordinated use of the two methods is of interest and reveals that the satellite images do not exclusively reflect morphology in our regions of temperate climate with considerable pedologic and vegetable covering.

f - Map of earthquakes

This map contains scattered and incomplete data which was given cartographic form by the Institut français du pétrole on the basis of indications by Professor ROTHE (Institut de physique du globe, Strasbourg).

This comparison shows that there is some degree of dependence between earthquakes and the Armorican trend but the excessively small quantity of indications (approximately 15) denies all statistical value to this observation. Nevertheless it should be emphasized that there epicentres (for such a small group) are aligned on a 20° N trend which is only known through satellite data between Poitiers and Angoulême and are located at intersections with lineaments of the Armorican trend. This constitutes a subject of reflection as concerns the earthquake-fracture relation.

g - Geological map of the Quaternary and surface formations

This map was prepared by the CNRS and the University of Besançon. It shows that the hydrography taking the form of unfilled Quaternary formations plays a role which is not negligible but is not preponderant in the determination of satellite lineaments. This is particularly true as concerns the Quimper-Dinan-Avranches-Falaise accident which is not revealed hydrographically.

3.1.2 - Specific data

The Aiffres-Chef Boutonne depression:

Image 2186.10071 of 27 July 1975 covers a region extending from Limoges in the east to Niort in the west. The lithological contrasts are very clearly expressed including the unconformity of the sedimentary formations on the Massif Central basement. In the Niort region between the Boutonne river and the Sèvre Niortaise which drains the Marais marsh, the satellite image shows unambiguously that a relation exists at the level of alluvial unfilling. An identical phenomenon is also found further South between the Boutonne once again and the Rochefortais marsh. These corrections are closely linked to the Armorican fracture network. A recent work, the thesis of R. FACON (1954), furnishes confirmation and a complete explanation of the observations made near Niort (see fig. 4 and 5). It was, in fact, an old bed of the Boutonne which was affected by Armorican tectonism forcing it to shift south-east. From these observations a similar explanation can be given for the phenomenon observed further south. An interpretation of this kind which is allowed by the Landsat image presents some degree of interest in this calcareous region where the search for water poses serious problems.

The 140° N lineament-Vallet-Saint-Brieuc. We have chosen this example amongst others because it corresponds in part to an alignment of slight anomalies coinciding with Tertiary basins which have been interpreted by J.J. JAEGER on the basis of the gravimetric map. It is not necessary to review point by point this article which shows, on the basis of several

anomalies that an unconformity exists which up to then had not been revealed by the surface geology. The interpretation of the Landsat images:

- 1 - Confirms the existence of fractures with the same orientation at the level of the anomalies and the graben shape at the level of the small Tertiary basins;
- 2 - Reveals the real continuity of discontinuous geophysical observations;
- 3 - Thus stresses the importance of this lineament;
- 4 - Indicates possible extensions to the north and south. JAEGER had already conjectured that the Vallet anomaly which presented gravimetric characteristics like those of the other anomalies could represent an extension of the lineament towards the South. The Landsat image shows clearly that the alignment is interrupted by an accident N 140 Nantes-le-Lion d'Angers, but that it then continues, after shifting, on the Clisson granite. It continues still further as far as the well known Confolens fault in the Massif Central basement.

The "granite" of Saumur. The satellite image makes it possible to observe a group of faults and boundaries along the Loire between Angers and Saumur at the level of Cretaceous and Eocene outcrops, but independently of their shape. These faults and boundaries exactly reproduce the shape of a very important slight anomaly correlated by C. WEBER with a granitic axis recognized by drillings at Breze. Thus this granitic axis which corresponds to a major paleogeographical structure appears on the Landsat images and this constitutes the importance of this observation.

The Quimper-Lanion St-Pol-de-Léon triangle between these three points which constitute a triangle with its summit to the south, the Landsat images bring out an "anomalous" zone, since for the moment no basis for confirmation can be found on any of the maps with which it has been compared. The geological map, gravimetric map and metallogenic map do not supply any explanation of its existence. Its originality gives it particular interest especially as the eastern side of the triangle serves as a boundary between two distinct tectonic domains (verbal communication, AUTRAN). The characteristics of the zone are as follows:

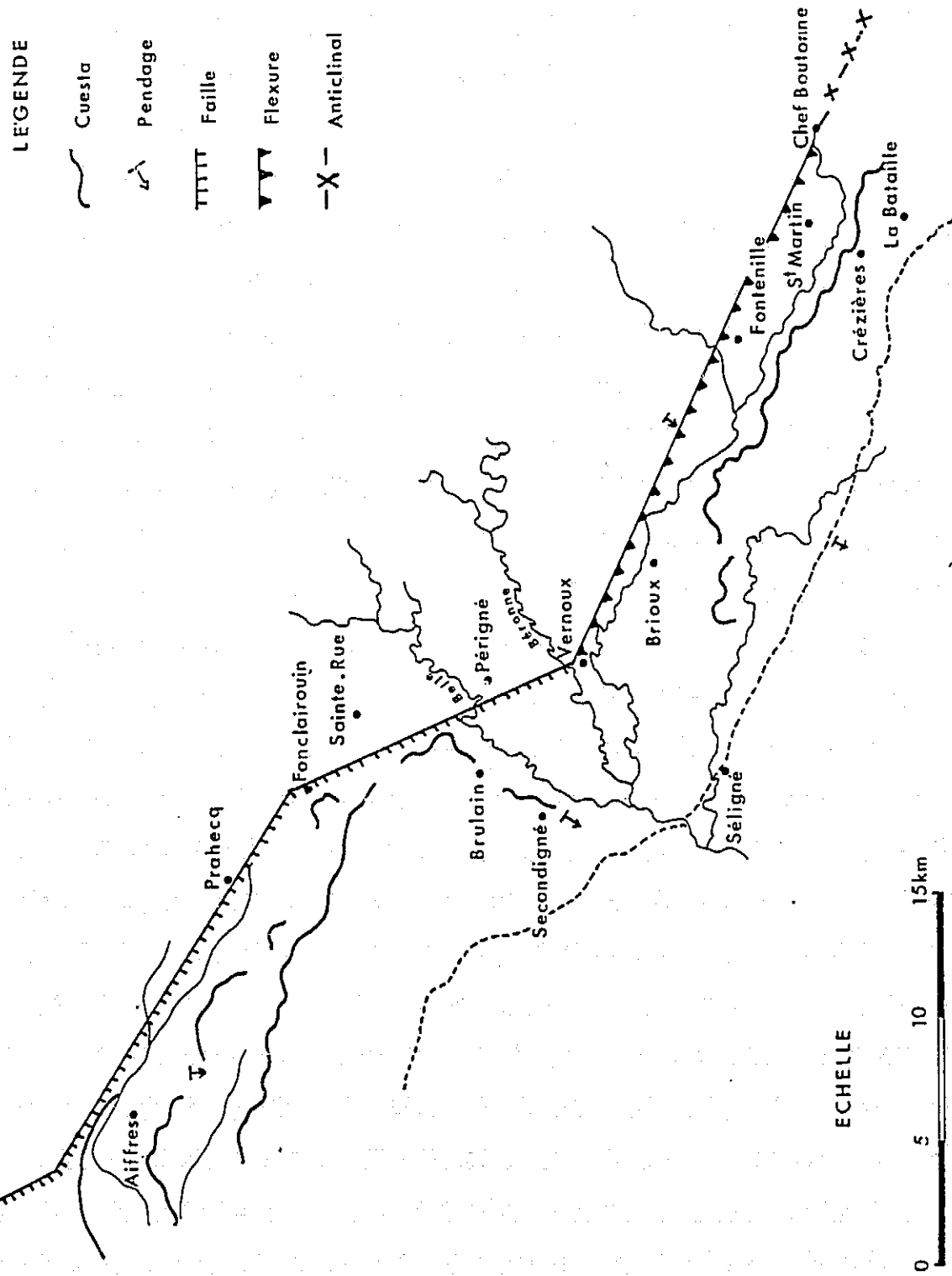
- The direction of the filtration shows that it takes place through faults oriented NE, SW.
- This is a zone of intense tectonism as is shown by the Q.T.M. analysis.
- Finally, it is a zone of high fracture density.

3.1.3 - Discussion of the results in relation to the objectives of the investigation

3.1.3.1 - *Structural analysis*

Preparation of a map of lineaments. In view of the excellent results obtained for the Massif Central with Landsat 1 satellite images the preparation of a map of the lineaments of the Armorican Massif was the major objective of this experimental study. As only five Landsat 2 images could be used and there was often considerable cloud cover, the map in the annex corresponds to the combined interpretation of Landsat 1 and 2 images, which is not of great importance because they have identical characteristics. It was then important to know whether a study of lineaments for another zone of our country could be made with similar quality and the reply was positive.

STRUCTURE DE LA DEPRESSION AIFRES - CHEF BOUTONNE



- LEGENDE
- Cuesta
 - Pendage
 - Faille
 - Flexure
 - Anticlinal

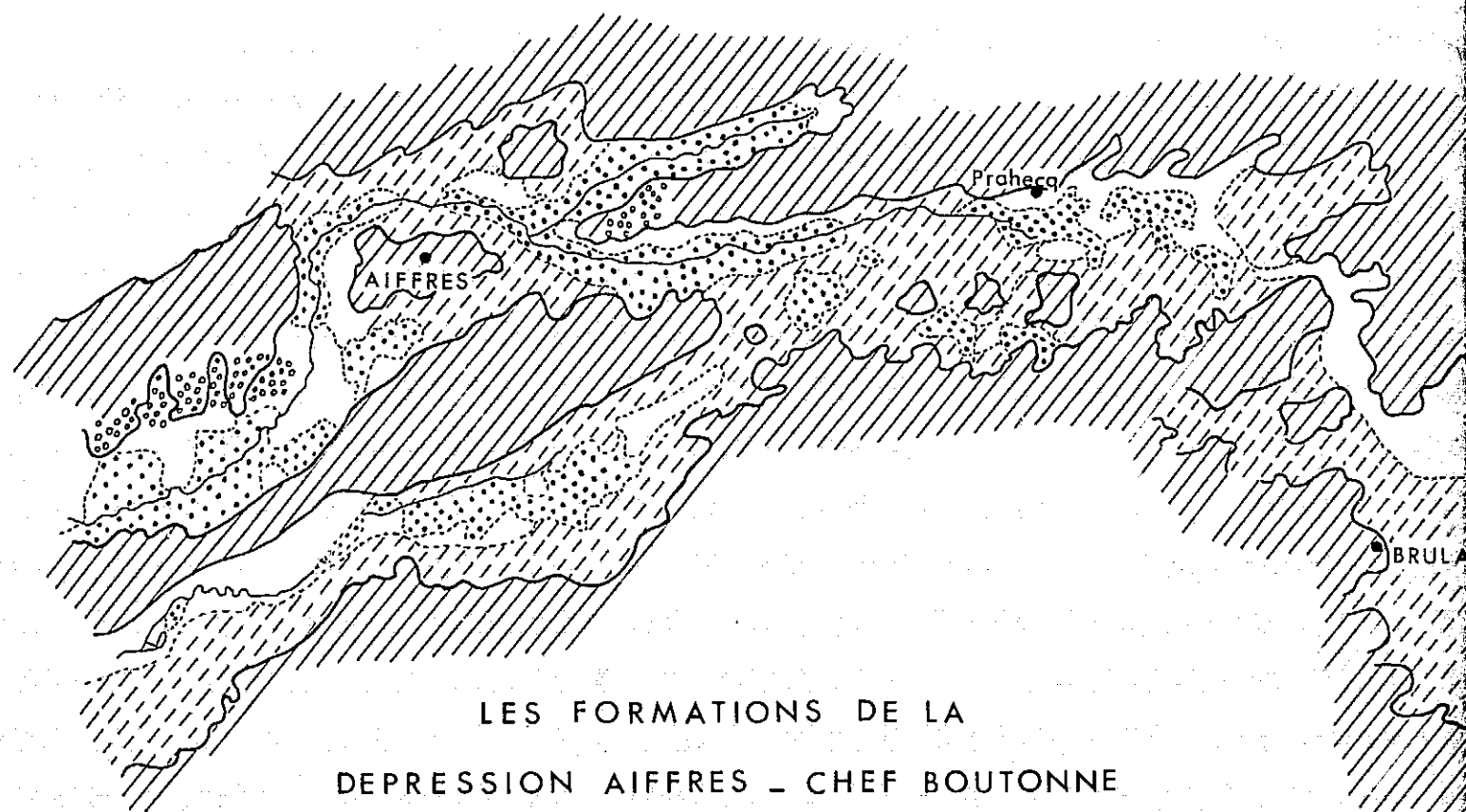
ECHELLE



(d'après Roger FACON, thèse 1954)

fig. 4

7a



LES FORMATIONS DE LA
DEPRESSION AIFFRES - CHEF BOUTONNE

(d'après Roger FACON, thèse 1954)

LEGENDE



Bords de l'auge fluviale



Lit fluvial inscrit dans



Alluvions anciennes



a } Formations fluvio - pé



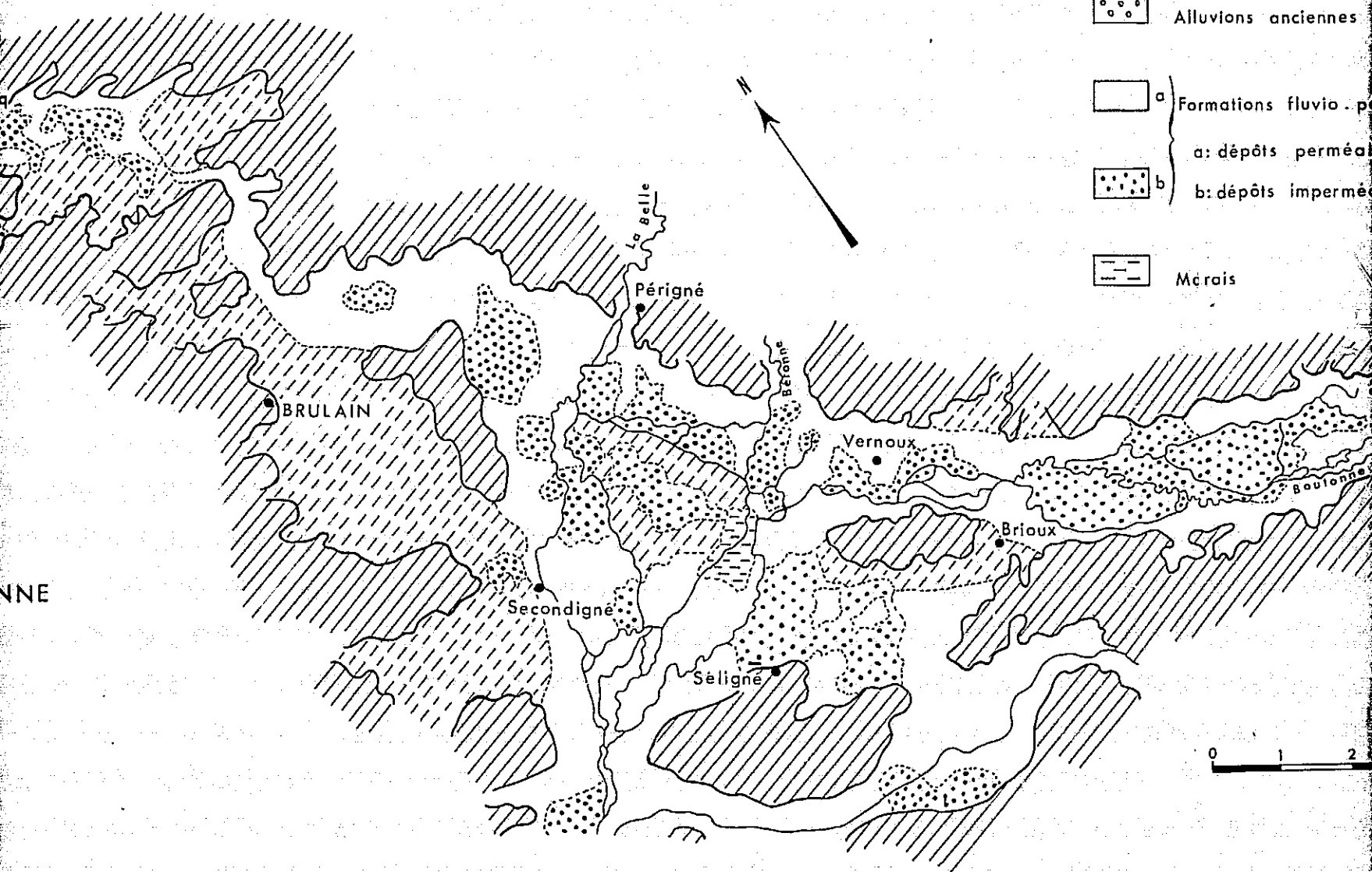
a: dépôts perméables



b: dépôts imperméables



Méris



LEGENDE



Bords de l'auge fluviale



Lit fluvial inscrit dans la roche en place



Alluvions anciennes



a } Formations fluviopériglaciaires

a: dépôts perméables



b } b: dépôts imperméables des lits mineurs abandonnés



Marais

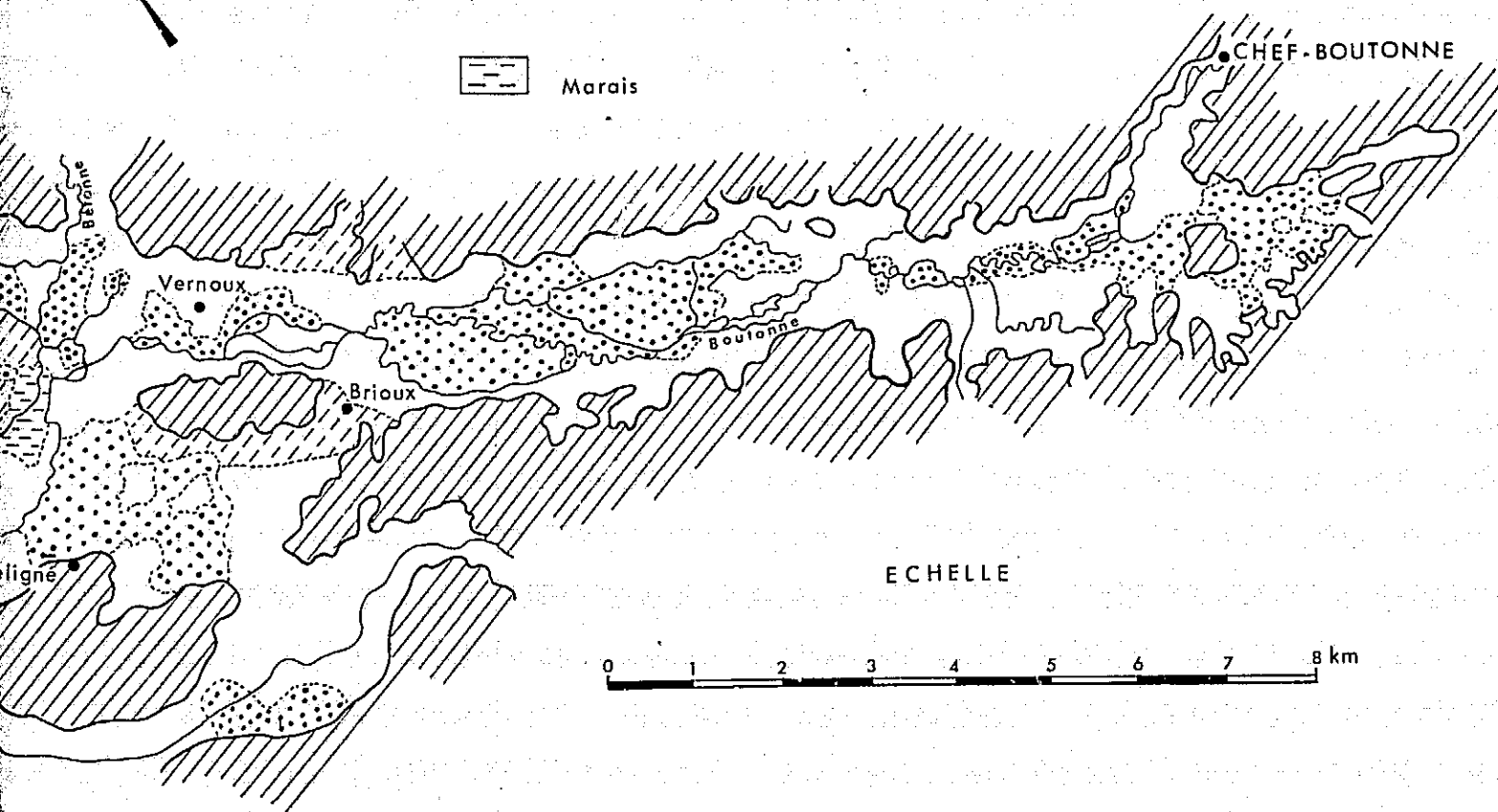


fig. 5

The map of lineaments of the Armorican Massif is an interesting document for several reasons:

1 - We have seen in preceding chapters that this document was coherent in relation to the geological knowledge which has been acquired up to now through various techniques (geophysical, geological, etc.).

2 - Since the validity of data of spatial origin is established as concerns known facts, all new observations of this type acquire a special interest and there are a great many of this kind (see preceding chapters).

3 - Comparison of the geological maps and "satellite" lineaments makes it possible to verify that for the whole group of lineaments a certain number are due to fracturing while others have a different geological significance (foliation, granitic axis, etc.). The term lineaments is therefore perfectly appropriate.

4 - Comparison of the map of Massif Central lineaments and the Armorican Massif map reveals in the both cases, the existence of an original rhegmatic network. This justifies the concept of tectonic domain and authorizes a search for more precise criteria for regional differentiation, for example as concerns fracture density, intersection density, etc.. We have begun this research.

5 - In Brittany they are two principal lineaments which give the Armorican Massif a good part of their originality. While interpretation of satellite images makes it possible to confirm the importance of the southern lineament it leads to an under-estimation of the northern lineament. If the spatial information alone were concerned, it could have an interesting tectonic significance but unfortunately in this case it is possible that the unequal quality of the images could have affected the interpretation. It is a fact, and this is very clear for Brittany, that the quality of the spatial images is very irregular (leaving cloud cover out of account) for the same period as well as for spectra for the same zone. It is quite evident that the quality conditions interpretation and introduces "tectonic discontinuities" which are not natural and are harmful to the analysis.

Study of some particular problems.

It was hoped that by means of analysis of lineaments it would be possible to contribute to the solution of some of the problems posed in Brittany.

1 - Extension of certain lineaments.

The gravimetric map of France recently published by the B.R.G.M. makes it possible to interpret several important anomalies south of the Loire linked to the large southern Armorican anomaly. The alignment suggested by these geophysical discontinuities could be modified in terms of the interpretation of the spatial data. Without going into the details of a long comparison, the most important point of divergence concerns the link: Armorican belt - Marche fault. The extension of the Marche fault was already discussed in the final report to the NASA on the Massif Central (p. 18). This extension to the west is in accordance with the gravimetric data. The prolongation south-east towards the Massif Central of the Armorican accident can also be interpreted on the basis of gravimetric data as well as satellite data. The difference of opinions concerns the junction of the two accidents. While the gravimetry suggests a continuity after a quite important change of direction (NW-SE to E-W), the map of satellite lineaments indicates that there could be two different accidents crossing at a point located 10 km

west of Isle Jourdain, a small village on the river Vienne. The two lineaments continue further towards the south-west and the south-east. A coincidence should be pointed out there are indications of circular structure at this intersection of two important lineaments.

2 - Research on "Tertiary" sedimentary basins.

These basins are in general of small size and it was proposed to map them, essentially by making use of colored multispectral composites. The irregular quality of the various spectral bands in our possession did not make it possible to achieve the planned composite colors. However comparison with the gravimetric map (2.1.2) and the near alignment which appears between Vallet and St Briec revealed an indirect means for locating them or at least for locating "subsidence" zones which could have been favorable for the deposit of Tertiary sediment.

3 - The effects of the Hercynian orogeny.

In the Armorican Massif, the Hercynian orogeny is responsible for the folding of a part of the Cadomian. There is a region corresponding roughly to "Mancellia" (Normandy) which was not folded. The possibility is being sought of showing the existence of these two tectonic domains on the Landsat images. The mediocre quality of the images for this part of the zone of experimentation has not allowed this; but in the west of Brittany the example mentioned below shows that research of this kind is possible. It concerns the lineament Quimper-Lannion, the east side of the triangle Quimper-Lanion St-Pol-de-Léon. To the east and west of this lineament, tectonic geologists have indicated considerable tectonic change: to the east the Paleozoic has undergone only one phase of folding while there were two phases in the west. Thus although these folding phases do not appear directly, a lineament clearly emphasizes the boundary between the two domains.

4 - The granitic axes.

We will not reconsider this problem which has already been dealt with (2.11/b).

3.1.3.2 - Mineral exploration

Some conclusions can be drawn concerning this point of interest :

- . Comparison of the map of lineament with the metallogenic map of the Armorican Massif shows that there is no systematic correspondance between the non-stratiform deposits and the lineament trends whether privileged or not. The pourcentage of correlation is quite high but does not allow laws of distribution to be indicated.

- . Locally, the relation between certain privileged trends (Armorican) and certain mineralizations (Pb-Zn of the Poitou shelf) is confirmed.

- . This study also brings out the interest of certain special points (2.1.1.c).

- The circular structure and their intersection with the lineaments,
- The points of intersection of fractures in terms of their complexity,

- . Spatial images make it possible to visualize the movements between blocks (2.1.1.c) which could explain the distribution of certain kinds of deposits.

. A series of comparisons with metallogenic and geophysical maps is now being made in order to estimate the interest of the analytic processing with Q.T.M..

At the present stage of our knowledge and in the temperate climates of Europe where the pedological and vegetation horizon is important, it does not seem possible to attempt to detect, directly, mineralized bodies on satellite images by conventional interpretation but only to bring out in the lineament network a relation between network discontinuities and known areas of mineralization. This "model" can then be sought in places where deposits have not yet been discovered. This is the approach we are using in this study.

4 - SIGNIFICANT RESULTS

The significant results are of a scientific and methodological type. They concern:

- At the scientific level:

Preparation of an original map of the lineaments of the Armorican Massif and the Vendean platform;

Verification of the validity of spatial information through comparison with maps of various kinds: geological, geophysical, morphological, etc.;

Confirmation of the fact that the Landsat images in many cases (Saumur granite) reflect data on deep phenomena which are only accessible geophysically and by means of borings;

Outlining of tectonic domains;

Extension of known lineaments;

Complementary character of studies on aerial photographs and spatial images;

Improvement of geophysical interpretation;

Search for circular structure and their links with lineaments and certain mineralized bodies.

- At the methodological level:

With the Q.T.M. perfection, of a method for the analysis of the lineament network. This research continues and the definition of "discontinuities" in the shape of the rhegmatic network is expected to result from it;

Verification of the possible interest of obtaining improved images from digital tape.

All these results have a direct application to operational problems. Their verified credibility, the originality of the results, the accessibility to certain sub-surface data and the complementary character of the aerial and spatial approaches encourage the utilization of Landsat images in many geological studies as well as in mining and land-use planning research.

5 - PUBLICATIONS

As yet there have been no publications on the results for the Armorican Massif.

6 - PROBLEMS

There are two important problems:

- The problem of the plotting of the spatial data interpretations. The error resulting from the process utilized is still too great and makes the map of lineaments less precise.

- The quality of the images received is too unequal for the uniformity of interpretation necessary for all analytic processing.

7 - DATA QUALITY

The following images were utilized:

24 august	72 1232	10405	5-4	Tip Brittany
10 march	72 1230	10415	5-7	"
6 june	75 2135	10235	4.5.6.7	North Brittany
9 march	73 1229	10361	5	"
30 july	75 2189	10233	6.7.5	Brittany
22 sept.	72 1066	10291	6.4.7	Cotentin (Cloudy)
8 march	73 1228	10302	5.6	Cotentin (Cloudy)
11 july	73 1353	10244	5.7	Oléron Charentes
22 sept.	72 1066	10294	5.7	South Brittany
March	73 1229	10363	5	"
July	75 2189	10235	5	"
July	73 1353	10244	5	"
July	75 2187	10125	5.6.7	Charentes
July	75 2186	10071	5.7	Vendée Charentes

In general band 5 is good and is often the only one utilisable; and band 7 is rarely good and in general is very pale.

This problem of quality seems to be linked to the fact that ocean and continent are on the same image. An identical problem, but this time solely terrestrial, was encountered on image 2186-10071 of 27 July 1975. This image covers both sedimentary formations, which appear clearly, and basement formations which are very dark.

In both cases it can be asked whether the problem is due to the realization of the image by the M.S.S. or whether it is in the display.

8 - RECOMMENDATIONS

Since all researchers cannot have access to "improved" images which they could display themselves from magnetic tapes the NASA should pay special attention to the display of negatives, for results depend upon the quality of the image being interpreted.

9 - CONCLUSIONS

As users of "satellite" images since 1972 in geologically related fields we are convinced of the usefulness of spatial data. The desired results should be considered in terms of supportive character which the method now has. These results are at once of a short and medium term nature depending upon the character of the research.

Applications of satellite data interpretation can be considered within the framework of multiple comparisons with data furnished by other techniques of geological research. B.R.G.M. is already using spatial data in this way for the realization of large-scale projects concerning the French territory.

- Participation in the establishment of the seismic and tectonic map of France in order to facilitate the choice of locations for future energy production centres;

- Participation in metropolitan mining research especially in the Massif Central and the Armorican Massif;

- Regular geological mapping of France at 1/50,000.

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CARTE DES LINEAMENTS DE SATELLITE

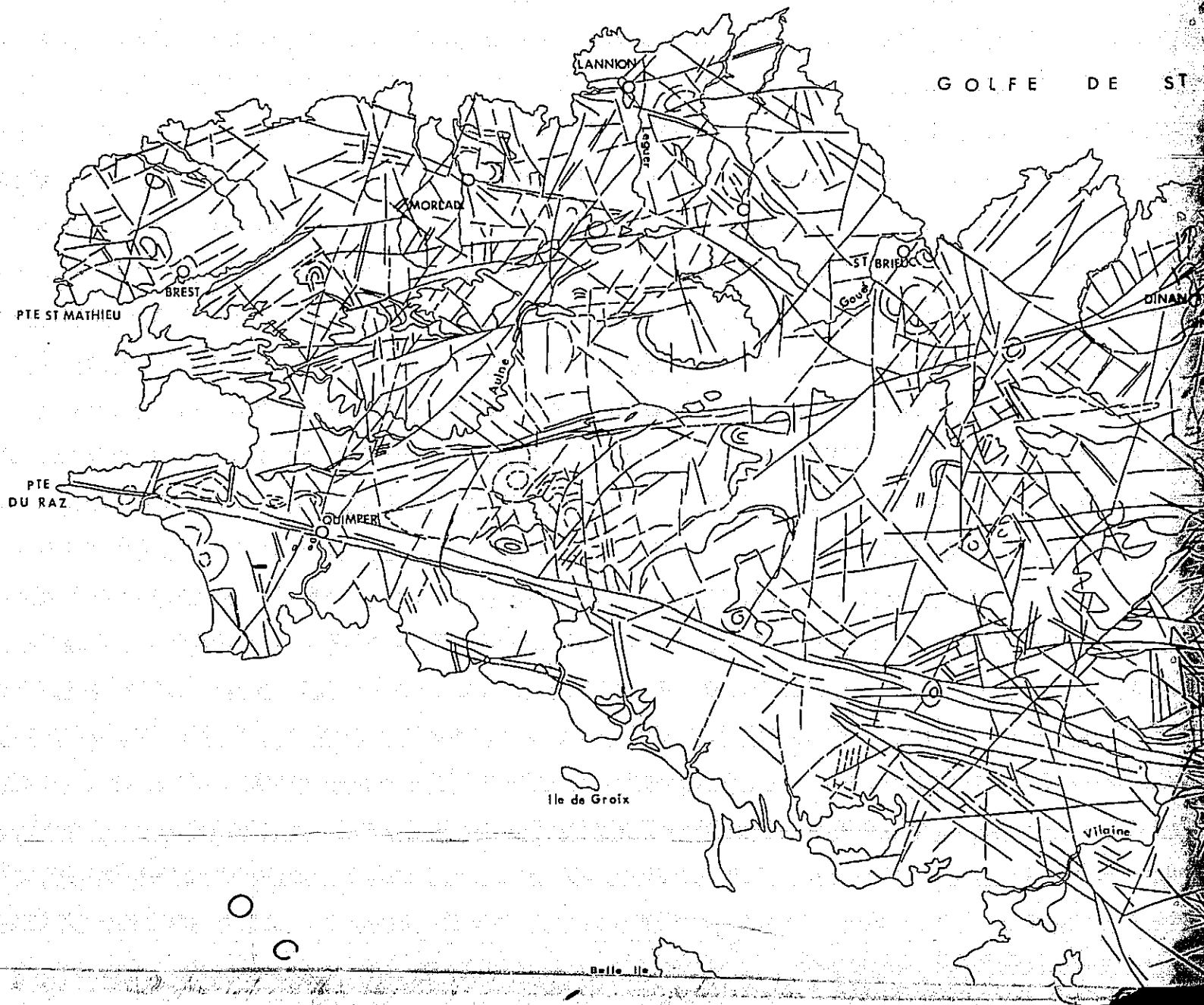
(Landsat 1 et 2)

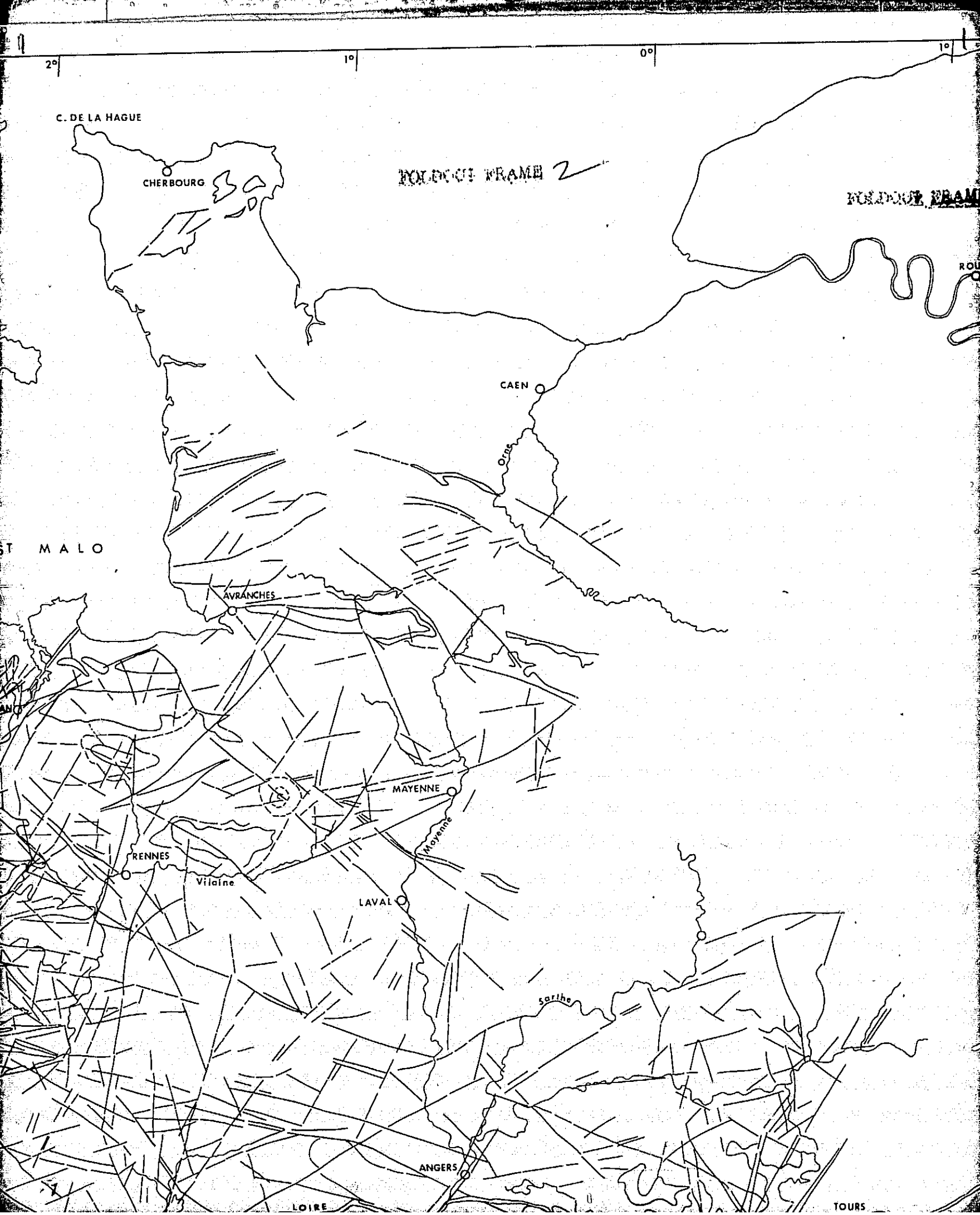
Guernsey

Jersey

LA MANCHE

GOLFE DE ST





C. DE LA HAGUE

CHERBOURG

WOLDCOT FRAME 2

WOLDCOT FRAME

CAEN

ST MALO

AVRANCHES

MAYENNE

RENNES

Vilaine

LAVAL

ANGERS

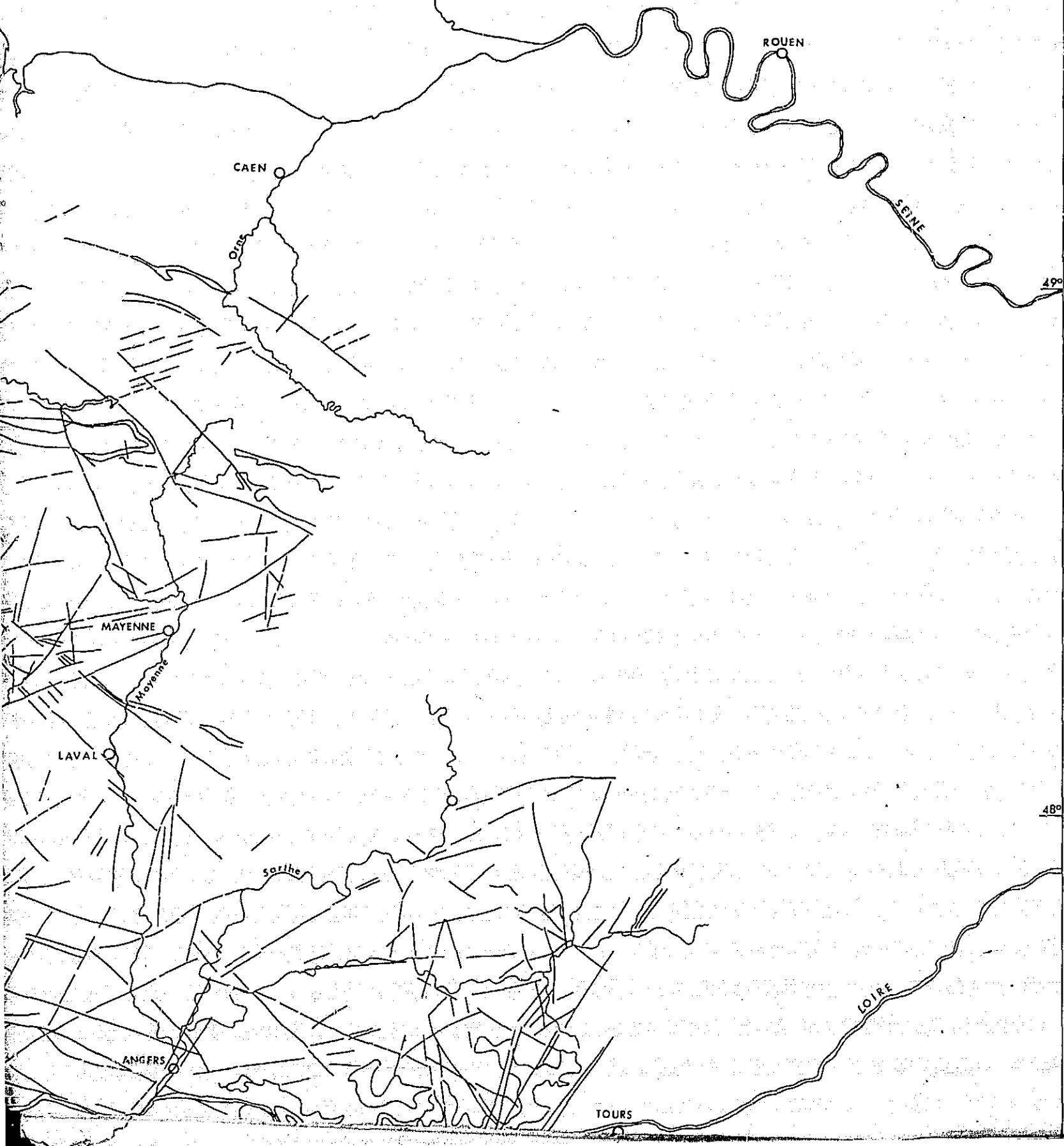
Sarthe

LOIRE

TOURS

FOLDOUT FRAME 2

FOLDOUT FRAME 3



47°

FOLIOST FRAME 4

ATLANTIQUE

Ile de
Noirmoutier

Ile d'Yeu

46°

Echelle : 1/1 000 000



45°

4°

3°

2°



NANTES

I. de
Grand lieu

Sevre Nantaise

BOUDOUL TRAINS

Cher

Indre

Creuse

CHÂTELLERAUT

Vienne

POITIERS

Clain

Ile de Ré

LA ROCHELLE

Ile d'Oléron

Boulonne

Charente

SAINTES

Saumur

CONFOLENS

ANGOULÊME

GIRONDE

10°

0°

10°

